NCERT SOLUTIONS

CLASS - 9th

Class : 9th
Subject : SCIENCE
Chapter : 4
Chapter Name : STRUCTURE OF THE ATOM

Q1 What are canal rays?

Answer. Canal rays are positively charged radiations. These rays consist of positively charged particles known as protons. They were discovered by Goldstein in 1886.

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Q2 If an atom contains one electron and one proton, will it carry any charge or not?

Answer. An electron is a negatively charged particle, whereas a proton is a positively charged particle. The magnitude of their charges is equal. Therefore, an atom containing one electron and one proton will not carry any charge. Thus, it will be a neutral atom.

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Q1 On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole.

Answer.According to Thomson's model of the atom, an atom consists of both negatively and positively charged particles. The negatively charged particles are embedded in the positively charged sphere. These negative and positive charges are equal in magnitude. Thus, by counterbalancing each other's effect, they make an atom neutral.

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Q2 On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom?

Answer. On the basis of Rutherford's model of an atom, protons (positively-charged particles) are present in the nucleus of an atom.

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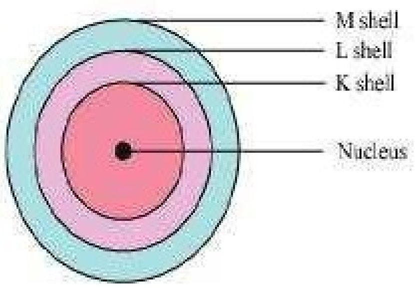
Q3 Draw a sketch of Bohr's model of an atom with three shells.

Answer. Draw a sketch of Bohr's model of an atom with three shells.



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Q4 What do you think would be the observation if the α-particle scattering experiment is carried out using a foil of a metal other than gold?

Answer. If the a-scattering experiment is carried out using a foil of a metal rather than gold, there would be no change in the observation. In the a-scattering experiment, a gold foil was taken because gold is malleable and a thin foil of gold can be easily made. It is difficult to make such foils from other metals.

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Q1 Name the three sub-atomic particles of an atom?

Answer. The three sub-atomic particles of an atom are:
(i) Protons
(ii) Electrons, and
(iii) Neutrons

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Q2 Helium atom has an atomic mass of 4u and two protons in its nucleus. How many neutrons does it have?

Answer. Helium atom has two neutrons. The mass of an atom is the sum of the masses of protons and neutrons present in its nucleus. Since helium atom has two protons, mass contributed by the two protons is (2 x 1) u = 2 u. Then, the remaining mass (4 - 2) u = 2 u is contributed by 2u/1u = 2 neutrons.

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Q1 Write the distribution of electrons in carbon and sodium atoms.

Answer. The total number of electrons in a carbon atom is 6. The distribution of electrons in carbon atom is given by:
First orbit or K-shell = 2 electrons

Second orbit or L-shell = 4 electrons
Or, we can write the distribution of electrons in a carbon atom as 2, 4.
The total number of electrons in a sodium atom is 11. The distribution of electrons in sodium atom is given by:
First orbit or K-shell = 2 electrons
Second orbit or L-shell = 8 electrons
Third orbit or M-shell = 1 electron
Or, we can write distribution of electrons in a sodium atom as 2, 8, 1.

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Q2 If K and L shells of an atom are full, then what would be the total number of electrons in the atom?

Answer. The maximum number of electrons that can occupy K and L-shells of an atom are 2 and 8 respectively. Therefore, if K and L-shells of an atom are full, then the total number of electrons in the atom would be (2 + 8) = 10 electrons.

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Q1 How will you find the valency of chlorine, sulphur and magnesium?

Answer. If the number of electrons in the outermost shell of the atom of an element is less than or equal to 4, then the valency of the element is equal to the number of electrons in the outermost shell. On the other hand, if the number of electrons in the outermost shell of the atom of an element is greater than 4, then the valency of that element is determined by subtracting the number of electrons in the outermost shell from 8. The distribution of electrons in chlorine, sulphur, and magnesium atoms are 2, 8, 7; 2, 8, 6 and 2, 8, 2 respectively. Therefore, the number of electrons in the outer most shell of chlorine, sulphur, and magnesium atoms are 7, 6, and 2 respectively.
Thus, the valency of chlorine = 8-7 = 1
The valency of sulphur = 8 - 6 = 2
The valency of magnesium = 2

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Q1 If number of electrons in an atom is 8 and number of protons is also 8, then
(i) what is the atomic number of the atom? and
(ii) what is the charge on the atom?

Answer. (i) The atomic number is equal to the number of protons. Therefore, the atomic number of the atom is 8.
(ii) Since the number of both electrons and protons is equal, therefore, the charge on the atom is o.

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Q2 With the help of Table 4.1, find out the mass number of oxygen and sulphur atom.

Answer. Mass number of oxygen = Number of protons + Number of neutrons
=8+8
= 16
Mass number of sulphur = Number of protons + Number of neutrons
= 16 +16
= 32

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Q1 For the symbol H,D and T tabulate three sub-atomic particles found in each of them.

Answer.

Symbol	Proton	Neutron	Electron
H	1	0	1
D	1	1	1
T	1	2	1

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Q2 Write the electronic configuration of any one pair of isotopes and isobars.

Answer. Two isotopes of carbon are ${}^{12}_{6}\mathrm{C}$ and ${}^{14}_{6}\mathrm{C}$.
The electronic configuration of ${}^{12}_{6}\mathrm{C}$ is 2,4.
The electronic configuration of ${}^{12}_{6}\mathrm{C}$ is 2,4.
[Isotopes have the same electronic configuration]
${}^{40}_{20}\mathrm{Ca}$ and ${}^{40}_{18}\mathrm{Ca}$
The electronic configuration of ${}^{40}_{20}\mathrm{Ca}$ is 2,8,8,2
The electronic configuration of ${}^{40}_{18}\mathrm{Ca}$ is 2,8,8

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Q1 Compare the properties of electrons, protons and neutrons.

Answer.

Electron		Proton		Neutron	
(i)	Electrons are present outside the nucleus of an atom.	(i)	Protons are present in the nucleus of an atom.	(i)	Neutrons are present in the nucleus of an atom.
(ii)	Electrons are negatively charged.	(ii)	Protons are positively charged.	(ii)	Neutrons are neutral.
(iii)	The mass of an electron is considered to negligible.	(iii)	The mass of a proton is approximately 2000 times as the mass of an electron.	(iii)	The mass of neutron is nearly equal to the mass of a proton.

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Q2 What are the limitations of J.J. Thomson’s model of the atom?

Answer. According to J.J. Thomson's model of an atom, an atom consists of a positively charged sphere with electrons embedded in it. However, it was later found that the positively charged particles reside at the centre of the atom called the nucleus, and the electrons revolve around the nucleus.

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Q3 What are the limitations of Rutherford’s model of the atom?

Answer. According to Rutherford's model of an atom, electrons revolve around the nucleus in fixed orbits. But, an electron revolving in circular orbits will not be stable because during revolution, it will experience acceleration. Due to acceleration, the electrons will lose energy in the form of radiation and fall into the nucleus. In such a case, the atom would be highly unstable and collapse.

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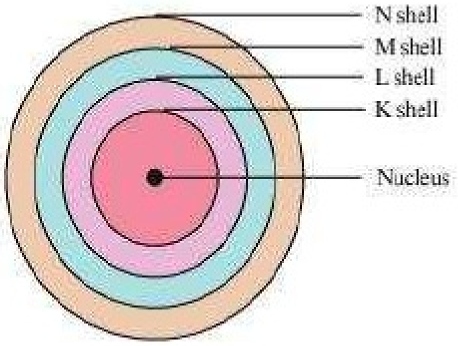
Q4 Describe Bohr’s model of the atom.

Answer. Bohr's model of the atom Niels Bohr proposed the following postulates regarding the model of the atom.
(i) Only certain orbits known as discrete orbits of electrons are allowed inside the atom.
(ii) While revolving in these discrete orbits, the electrons do not radiate energy. These discrete orbits or shells are shown in the following diagram.



The first orbit (i.e., for n = 1) is represented by letter K. Similarly, for n = 2, it is L - shell, for n = 3, it is M - shell and for n = 4, it is N - shell. These orbits or shells are also called energy levels.

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Q5 Compare all the proposed models of an atom given in this chapter.

Answer.

Thomson's model	**Rutherford's model**	**Bohr's model**
An atom consists of a positively charged sphere with electrons embedded in it.	An atom consists of a positively charged particles concentrated at the centre known as the nucleus. The size of the nucleus is very small as compared to the size of the atom. The electrons revolve around the nucleus in well-defined orbits.	There are only certain orbits known as discrete orbits inside the atom in which electrons revolve around the nucleus. Electrons do not radiate energy while revolving.

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Q6 Summarise the rules for writing of distribution of electrons in various shells for the first eighteen elements.

Answer. The rules for writing of the distribution of electrons in various shells for the first eighteen elements are given below.
(i) The maximum number of electrons that a shell can accommodate is given by the formula ' $2n^2$', where 'n' is the orbit number or energy level index (n = 1, 2, 3.„).
The maximum number of electrons present in an orbit of n = 1 is given by 2na
Similarly, for second orbit, it is $2n^2$= 8
For thild Orbit, it is = 2×3^2=18
And so
(ii) The outermost orbit can be accommodated by a maximum number of 8 electrons.
(iii) Shells are filled with electrons in a stepwise manner i.e., the outer shell is not

occupied with electrons unless the inner shells are completely filled With electrons.

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Q7 Define valency by taking examples of silicon and oxygen.

Answer. The valency of an element is the combining capacity of that element. The valency of an element is determined by the number of valence electrons present in the atom of that element. If the number of valence electrons of the atom of an element is less than or equal to four, then the valency of that element is equal to the number of valence electrons. For example, the atom of silicon has four valence electrons. Thus, the valency of silicon is four. On the other hand, if the number of valence electrons of the atom of an element is greater than four, then the valency of that element is obtained by subtracting the number of valence electrons from eight. For example, the atom of oxygen has six valence electrons. Thus, the valency of oxygen is (8 - 6) i.e., two.

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Q8 Explain with examples
(i) Atomic number,
(ii) Mass number,
(iii) Isotopes and,
(iv) Isobars,
Give any two uses of isotopes

Answer. (i) Atomic number
The atomic number of an element is the total number of protons present in the atom of that element. For example, nitrogen has 7 protons in its atom. Thus, the atomic number of nitrogen is 7.
(ii) Mass number
The mass number of an element is the sum of the number of protons and neutrons present in the atom of that element. For example, the atom of boron has 5 protons and 6 neutrons.
So, the mass number of boron is 5 + 6 = 11.
(iii) Isotopes
Isotopes are atoms of the same element having the same atomic number, but different mass numbers. For example, hydrogen has three isotopes. They are
protium $\left({}_1^1\mathrm{H}\right)$
deuterium $\left({}_1^2\mathrm{H}\right)$
and tritium $\left({}_1^3\mathrm{H}\right)$
(iv) Isobars
Isobars are atoms having the same mass number, but different atomic numbers i.e., isobars are atoms of different elements having the same mass number. For example,
_$20^{40}\mathrm{Ca}$ and _$18^{40}\mathrm{Ca}$
are isobars.
Two uses of isotopes are:

(i) One isotope of uranium is used as a fuel in nuclear reactors.
(ii) One isotope of cobalt is used in the treatment of cancer.

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Q9 Na^{+} has completely filled K and L shells. Explain

Answer. An atom of Na has a total of II electrons. Its electronic configuration is 2, 8, 1. But,Na^{+} ion has one electron less than Na atom i.e., it has 10 electrons. Therefore, electrons go to K-shell and 8 electrons go to L-shell, thereby completely filling K and L shells.

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Q10 If bromine atom is available in the form of, say, two isotopes $({}^{79}_{35}\mathrm{Br})$ (49.7%) and $({}^{81}_{35}\mathrm{Br})$ (50.3%), calculate the average atomic mass of bromine atom.

Answer. It is given that two isotopes of bromine are $({}^{79}_{35}\mathrm{Br})$ (49.7%) and $({}^{81}_{35}\mathrm{Br})$ (50.3%) then, the average atomic mass of bromine atom is given by:
$79 \times \frac{49.7}{100}+81 \times \frac{50.3}{100}$
$=\frac{8000.6}{100}$
=80.006u
=80(approx)

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Q11 The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $({}^{16}_{8}\mathrm{X})$ and $({}^{18}_{8}\mathrm{X})$ in the sample?

Answer. It is given that the average atomic mass of the sample of element X is 16.2 u.
Let the percentage of isotope $({}^{18}_{8}\mathrm{X})$ be y% Thus, the percentage of Isotope $({}^{16}_{8}\mathrm{X})$ will be (100-y)%.
Therefore,
$18 \times \frac{y}{100}+16\frac{(100-y)}{100}=16.2$
$=\frac{18y}{100}+\frac{16(100-y)}{100}=16.2v$
$=\frac{18y+1600-16y}{100}=16.2$
18y+1600-16y=1620
2y+1600=1620
2y=1620-1600
y=10
Therefore, the percentage of isotope $({}^{18}_{8}\mathrm{X})$ is 10%.
And, the percentage of isotope is (100 — 10) % = 90%.

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Q12 If Z = 3, what would be the valency of the element? Also, name the element?

Answer. By Z = 3, we mean that the atomic number of the element is 3. Its electronic configuration is 2, 1. Hence, the valency of the element is 1 (since the outermost shell has only one electron). Therefore, the element with Z = 3 is lithium.

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Q13 Composition of the nuclei of two atomic species X and Y are given as under?

X Y
Protons = 6 6
neutrons= 6 8
Give the mass numbers of X and Y. What is the relation between the two species?

Answer. Mass number of X = Number of protons + Number of neutrons
=6+6
= 12
Mass number of Y = Number of protons + Number of neutrons
=6+8
= 14
These two atomic species X and Y have the same atomic number, but different mass numbers. Hence, they are isotopes.

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Q14 For the following statements, write T for True and F for False.
(a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons.
(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral.
(c) The mass of an electron is about 1/2000 times that of proton.
(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine.

Answer. (a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons. (F)
(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral. (F)
(c) The mass of an electron is about 1/2000 times that of proton. (T)
(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine. (T)

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Q15 Rutherford’s alpha-particle scattering experiment was responsible for the discovery of
(a) Atomic Nucleus
(b) Electron
(c) Proton

(d) Neutron

Answer. Rutherford's alpha-particle scattering experiment was responsible for the discovery of
(a) Atomic nucleus (-)
(b) Electron (x)
(c) Proton (x)
(d) Neutron (x)

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Q16 Isotopes of an element have
(a) the same physical properties
(b) different chemical properties
(c) different number of neutrons
(d) different atomic numbers.

Answer. Isotopes of an element have
(a) the same physical properties (x)
(b) different chemical properties (x)
(c) different number of neutrons (—)
(d) different atomic numbers (x)

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Q17 Number of valence electrons in Cl^{-} ion are:
(a) 16
(b) 8
(c) 17
(d) 18

Answer. Number of valence electrons inCl^{-} Ion are:
(a) 16 (x)
(b) 8(-)
(c) 17 (x)
(d) 18 (x)

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Q18 Which one of the following is a correct electronic configuration of sodium?
(a) 2,8
(b) 8,2,1
(c) 2,1,8
(d) 2,8,1.

Answer. (d) The correct electronic configuration of sodium is 2, 8, 1.

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Q19 Complete the following table'

Atomic number	Mass number	Number of Neutrons	Number of protons	Number of electrons	Name of the Atomic species
9	–	10	–	–	–
16	32	–	–	–	Sulphur
–	24	–	12	–	–
–	2	–	1	–	–
–	1	0	1	1	–

Answer.

Atomic number	**Mass number**	**Number of Neutrons**	**Number of protons**	**Number of electrons**	**Name of the Atomic species**
9	**19**	10	**9**	**9**	**Fluorine**
16	32	**16**	**16**	**16**	Sulphur
12	24	**12**	12	**12**	**Magnesium**
1	2	**1**	1	**1**	**Deuterium**
1	1	0	1	1	**Protium**